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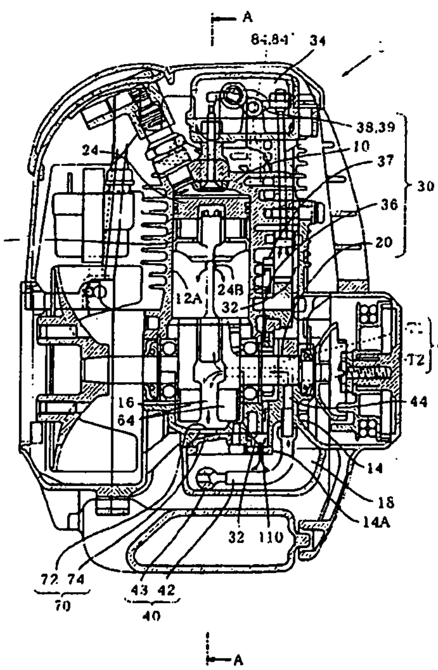
# (54) Lubricating apparatus in a four-stroke engines

(57) A lubricating apparatus for small-sized four-cycle engines to be used in portable type bush cutters, knapsack type powered sprayers, etc. In the lubricating apparatus, an oil returning channel (84, 84') is arranged to provide communication between a valve gear room (34) and an oil sump (18), and an oil inhaling channel (90) is branched from the middle of the oil returning channel so as to provide communication to an opening (24B) in an immediate lower portion of a skirt (24A) of a piston (24) being at the top dead center. By this means, when a crank room (16) is negatively pressurized, the oil sucked from the valve gear room is taken through the oil inhaling channel being in communication to a point inside a cylinder (12A) where the highest negative pressure is generated, and fed into the cylinder. An opening portion (84D) of the oil returning channel is provided with a check valve (100) for opening when the engine is upright and closing when the engine inverted or slanted to prevent the backflow of oil from the oil sump to the oil returning channel. In order to carry out the returning of oil to the oil sump securely, the valve gear room further comprises an oil inhaling means (130) being capable of immersing its extremity into the oil collected inside the valve gear room when the engine is put over sideways.

FIG.1

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**Description**

[0001] The present invention relates to a lubricating apparatus in a f ur-stroke engine, and more particularly to a lubricating apparatus in a small-sized four-stroke engine to be used in, for example, a portable typ bush cutter, a knapsack type powered sprayer, which take up a slanted position as one work posture.

[0002] Generally, an engine used as the power unit of a machine such as portable cutter (trimmer) for plants and a knapsack type powered sprayer to be carried by hand or on an operator's back in operation require operational stability even in cases where the machine is slanted in use.

[0003] Among various types of engines, two-stroke engines comprise a mechanism for carrying out the lubrication of moving parts by inducting lubricating oil and fuel into the engine by vacuum pressure created by a rising piston; it is therefore easy to construct a two-stroke engine capable of free-angle use (use at a slant). On this account, a two-stroke engine is often used in portable type machines.

[0004] A four-stroke engine can be made compact and light. However, because an oil sump (oil pan) part of the lubricating apparatus is arranged under a crank chamber and oil is splashed up or pumped up from the oil sump to lubricate the moving parts, four-stroke engines are supposed to be used in an upright attitude. In other words, a four-stroke engine lubricating apparatus is inferior to a two-stroke engine lubricating mechanism for use in portable hand held machines and the like.

[0005] However, a two-stroke engine has a problem in exhausting a relatively large amounts of hydrocarbon and is louder than a four-stroke engine. Accordingly, in terms of exhaust gas clean-up and improving a working-environment, it is desired to use a four-stroke engine.

[0006] In view of the foregoing, the applicant has previously proposed a lubricating apparatus for a four-stroke engine which utilises the phenomenon that the pressure in a crank chamber varies in accordance with the up-and-down movement of a piston (e.g., Japanese Patent Application Laid-Open No. Hei 10-288019).

[0007] In JP-A-10-288019 the oil sump and the crank chamber completely shut off from each other. An intermittent oil feed means is arranged from the oil sump to a portion in the rotational track of a crankshaft to provide communication between the oil sump and the crank chamber so that oil is inducted from the oil sump and fed into the crank chamber by means of a vacuum pressure in the crank chamber. The crank chamber communicates with a valve gear space equipped with a cam mechanism and the installation place of valve drive mechanisms (rocker cover) to forcedly send (inject/spray) oil mist agitated in the crank chamber under pressure generated inside the crank chamber into the rocker cover when a piston descends.

[0008] Blowby gas containing the oil mist fed into the valve gear chamber is recovered in the sump by means of a vacuum pressure tend ncy of th oil sump. In other words, by the action f the vacuum pressure inside the crank chamber created by the ascent of the piston.

[0009] The pressure in th il sump increases with a rise in cylinder temperatur once the engine is started. On account of this, oil recovery from the valve gear chamber to the oil sump is sometimes poor because sufficient vacuum pressure cannot be obtained inside the oil sump. Excessive oil is therefore retained inside the valve gear chamber depriving other engine parts of lubricating oil.

[0010] The four-stroke engine may be used in an attitude with the piston reciprocating vertically and the crank shaft rotating horizontally, or in an attitude with the piston reciprocating horizontally and the crank shaft rotating about a vertical axis. Application in a lawn mower may use a vertical crank shaft.

[0011] In the cases where the crankshaft is vertical the engine takes a sideways position in which a recoil starter is directed up and the reciprocation direction of the piston is horizontal. In this case an opening is provided in the valve gear chamber which communicates with an oil return passage to return oil to the sump. The oil surface in the valve gear chamber may escape the opening hampering oil return to the sump. In the case where a slidably supported portion of a valve is left immersed in the oil, the oil penetrates into the combustion chamber via the slidably supported portion, possibly causing the adverse effects of defective combustion with consequences such as white smoke emission and carbon deposition on the muffler.

[0012] An object of the present invention is to provide a lubricating apparatus in a four-stroke engine capable of carrying out lubrication in any work posture especially a slanted posture.

[0013] Accordingly a first aspect of the present invention provides a lubricating apparatus in a four-stroke engine, for feeding oil from an oil sump provided in the vicinity of a crank chamber to the crank chamber and to a valve gear chamber containing an intake and exhaust valve mechanism to carry out lubrication of parts and circulate the oil,
characterised in that:

> the oil sump is partitioned from the crank room to avoid oil leakage in a slanted engine posture, a first oil feeding means has an inlet portion configured so that the extremity thereof always remains under the oil surface in the oil sump regardless of the slanted posture of the oil sump, the first oil feeding means feeds the oil in the oil sump through the inlet portion to the crank chamber by means of a vacuum pressure generated in the crank chamber, an agitating section is provided in the crank room for agitating the oil fed by the first oil feeding means into an oil mist, a channel communicating between the crank chamber and the valve gear chamber, a second oil feeding means for feeding the oil mist in the crank

room through th communicating channel to the valve gear chamber by means of a high pressure generated in the crank chamber, and an oil induction channel branching from the middle of an oil return channel to communicate with an opening positioned in a lower portion of a skirt of a piston, when the piston is at top dead center, the oil return channel communicating between the valve gear chamber and the oil sump;

and an opening portion of the oil return channel to the oil sump is provided with a check valve which opens when the engine is upright and closes when the engine is inverted or slanted.

[0014] According to the first aspect of the present invention, the oil return channel is arranged in the crankcase. When a vacuum is present in the crank chamber oil is inducted from the valve gear chamber and taken into the oil induction channel. The oil induction channel is in communication with a point within the cylinder where the highest vacuum is generated. By this means, the highest vacuum obtained on the arrival of the piston at top dead center can by utilised to feed the oil from the valve gear chamber into the cylinder. This can prevent a lack of lubricating oil inside the cylinder without being greatly affected by a change in pressure in the oil sump.

[0015] The check valve prevents the backflow of oil from the oil sump to the oil return channel when the engine is in an inverted or slanted state. This prevents excessive lubrication which might otherwise occur in some work postures of the engine.

[0016] In the above system, the check valve may be composed of a spherical body for opening and closing the opening portion by means of its own weight. Since the check valve comprises a spherical body which is capable of moving in response to the pull of gravity in the inverted or slanted state of the engine, the check valve can securely close the oil return channel when the engine is inverted or slanted. This prevents excessive oil induction in the valve gear chamber in some work postures of the engine and maintains proper lubrication.

[0017] A pore for providing communication with the oil sump may be arranged in the communicating channel. The pore can adjust the oil mist fed to the valve drive mechanism and the valve gear chamber to a proper amount by releasing an excess of oil mist to the oil sump.

[0018] A breather pipe may communicate from the valve gear chamber to a breather chamber of an air cleaner. A pipe may communicate between the breather chamber and an oil induction opening formed in a lower portion of the skirt of the piston when the piston is at top dead center. Thus, oil held in a lower part of the breather chamber is fed into the cylinder through the oil induction opening when the piston is at the top dead center.

[0019] The oil contained in the blowby gas recovered from the valve gear chamber can be recovered in the breather chamber and supplied to the cylinder before collection in the oil sump. Here, the highest vacuum pressure generated on the arrival of the piston at top dead center is applied to the breather chamber to induc oil into the cylinder without being affected by changes in pressure in the oil sump. It is therefore, possible to lower the consumption of oil as well as prevent a lack of lubricating oil so suppressing maintenanc costs.

[0020] Another object of the present invention is to provide a lubricating apparatus in a four-stroke engine capable of preventing defective combustion and of reliably carrying out the recovery of oil inside a valve gear chamber mainly in using the engines in a sideways state.

[0021] A second aspect of the present invention is to provide a lubricating apparatus in a four-stroke engine, for feeding oil from an oil sump provided in the vicinity of a crank chamber to the crank chamber and to a valve gear chamber containing an intake and exhaust valve mechanism to circulate the oil, characterised in that:

the oil sump is partitioned from the crank chamber to avoid oil leakage in any slanted state;

a first oil feed means has an inlet portion configured so that an extremity always remains under the oil surface in the oil sump regardless of the slanted state of the oil sump, the first oil feed means feeds the oil in the oil sump through the inlet portion to the crank chamber by means of a vacuum pressure generated in the crank chamber, an agitating section is provided in the crank chamber for agitating the oil to an oil mist, a communicating channel for providing communication between the crank chamber and the valve gear chamber, a second oil feed means for feeding the oil mist in the crank chamber through the communicating channel to the valve gear chamber by means of a high pressure generated in the crank room, and an oil induction channel branching from the middle of an oil return channel to communicate with an opening positioned in a lower portion of a skirt of a piston at top dead center, the oil return channel communicates between the valve gear chamber and the oil sump;

and the oil return channel has an oil suction means detachably arranged on its opening in the valve gear chamber;

and the oil suction means is capable of immersing an extremity into the oil when the engine is put over sideways.

[0022] By virtue of the second aspect of the invention the oil return channel and the oil can be continuously kept in communication to ensure the return of oil to the oil sump chamber. Intrusion into the combustion chamber via the slidably supported portion of the valve is therefore prevented to avoid defective combustion.

[0023] The oil suction means may be composed of a pipe formed from the oil return channel bent toward the inside of the oil and freely rotatable about the longitudinal axial center of the oil return channel. The pipe may

have a w ight mounted on the extremity thereof t ensure immersion in the oil.

[0024] Alternatively, the oil suction means may be formed of a flexible pipe, and may have a weight mounted on the extremity thereof to be immersed into the oil.

[0025] Since the oil suction means is immersed into oil, in any posture of the engine the intake of oil into the oil return channel is ensured. The recovery of oil from the valve gear chamber is ensured and defective combustion resulting from the intrusion of oil into the combustion chamber prevented.

[0026] A lubricating system in a four-stroke engine constructed in accordance with the present invention will now be described with reference to the accompanying drawings, in which:-

Fig. 1 is a sectional view of a four-stroke engine with the lubricating apparatus according to a first embodiment of the present invention is applied, as seen from the front;
Fig. 2 is a sectional view on A-A in Fig. 1;
Fig. 3 is a sectional view on A-A with other parts shown;
Fig. 4 is a sectional view of a four-stroke engine with a lubricating apparatus according to a second embodiment, as seen in a direction orthogonal to the axis of the crankshaft;
Fig. 5 is a sectional view of the four-stroke engine according to the second embodiment seen from an end of the crankshaft;
Fig. 6 is a view on B-B in Fig. 5;
Fig. 7 is a sectional view of a main structure of the lubricating apparatus in the four-stroke engine of the second embodiment;
Fig. 8 is a view showing an extremity of the main structure shown in Fig. 7; and
Fig. 9 is a view showing a modified example of the extremity of the main structure shown in Fig. 7.

[0027] In the following description the term "four-cycle engine" may be used instead of "four-stroke engine". The term "room" may substitute for "chamber". The term "negative pressure" may substitute for "vacuum pressure" and "positive pressure" for "high pressure".

[0028] Fig. 1 is a front sectional view of a four-cycle engine to which the lubricating apparatus according to an embodiment of the present invention is applied. Figs. 2 and 3 are a sectional view with portions seen in the direction shown by symbols A in Fig. 1 and a sectional view with other portions seen in the direction shown by the symbols A in Fig. 1, respectively.

[0029] The four-cycle engine shown in Fig. 1 is provided with the constitution disclosed in the specification document appended to the application form in Japanese Patent Application Laid-Open No. Hei 10-288019 as its principal part. Hereinafter, description will be given of the above-mentioned constitution before the description of the present embodiment.

[0030] A four-cycle engine 1, as shown in Fig. 2, comprises air cleaner 2 and a carburettor 4 arranged on th left side and an exhaust muffler 6 on the right side. The four-cycle engine 1 further comprises: a crank room 16 composed of a crankcase 14 and a cylinder block 12 integrated with a cylinder head 10; and an oil sump 18 provided in the vicinity of the lower portion of the crankcase 14. The oil sump 18 is partitioned from the crankcase 14 with a partition wall 14A, forming an hermetically sealed space as a whole.

[0031] In Fig. 1, the crankcase 14 over the partition wall 14A is provided with an inlet portion 40 as described below and a unidirectional valve 70. The unidirectional valve 70 is constituted so as to be opened and closed in accordance with a change in pressure inside the crank room 16, and is closed in the case of no pressure change to avoid outward oil leakage in any slanted position of the oil sump 18.

[0032] To the cylinder block 12 and the crankcase 14 is, as shown in Fig. 1, rotatably supported a crankshaft 20 with its axis horizontal. A piston 24 connected via a connecting rod to a crank pin of the crankshaft 20 is slidably fitted into a cylinder 12A provided inside the cylinder block 12.

[0033] In Fig. 2, in upper walls of the cylinder 12A are formed an intake port 12A1 and an exhaust port 12A2 in communication with the carburetor 4 and the exhaust muffler 6, respectively. To the ports are arranged an intake valve 27 and an exhaust valve 28 for opening and closing the ports, respectively.

[0034] A valve drive section 30 for driving these valves is, as shown in Fig. 1, composed of such component parts as a valve drive gear 36, a cam gear 27, and rocker arms 38, 39. Among these component parts of the valve drive section 30, the valve drive gear 36 and the cam gear 37 are arranged in a communicating channel 32, which is formed at side portions of the cylinder block 12 and the crankcase 14 so as to provide communication between the crank room 16 and a valve gear room 34 formed in the cylinder block 12.

[0035] Between the crank room 16 and the oil sump 18 are provided the inlet portion 40, a path 44, and an intermittent oil feeding section 46 as a first oil feeding means.

[0036] In Fig. 1, the inlet portion 40 is composed of a flexible tube 42 of elastic material such as rubber and a weight 43 attached to an end thereof. More specifically, the weight 43 is provided so as to always move vertically downwards by means of its own weight to keep the end of the inlet portion 40 immersed under the oil surface even when the oil sump 18 is slanted.

[0037] The other end of the inlet portion 40 is communicated with the path 44 piercing through the crankcase 14. The path 44 forms an arcuate opening at a portion facing to the outer periphery of the crankshaft 20.

[0038] In Fig. 1, the intermittent oil feeding section 46 through the crankshaft 20 is composed of: a path T1 of a prescribed internal diameter drilled from a crank room

16 side through the vicinity of the cent r of the crankshaft 20 without piercing through outside; and a path T2 drilled in a radial direction into the crankshaft 20 to be connected to the path T1. The path T2 is provided so as to be communicated with the path 44 in the crankcase 14 within rotating angles of the crankshaft 20 corresponding t the negative-pressurization of the crank room 16 resulting from the ascending of the piston 24. In other words, the path T2 and the path 44 in the crankcase 14 are to be brought into communication in the process of a full revolution of the crankshaft 20.

[0039] Therefore, in the ascending of the piston 24, oil is inhaled from the oil sump 18 into the crank room 16 by means of a negative pressure generated in the crank room 16 when the inlet portion 40, the path 44, and the intermittent oil feeding section 46 are communicated through.

[0040] In Fig. 1, the crank room 16 comprises agitating sections for agitating the oil fed by the first oil feeding means into oil mist.

[0041] More specifically, the agitating sections are composed mainly of crank webs 64 fixed to the crankshaft 20.

[0042] In Figs. 1 and 2, between the crank room 16 and the communicating channel 32 is provided a unidirectional valve 70 as a second oil feeding means.

[0043] The unidirectional valve 70 is composed of a valve hole 72 piercing through a lower portion of the crankcase 14, and a valve plate 74 for opening the valve hole 72 when the crank room 16 becomes positive in pressure and closing the valve hole 72 when the crank room 16 becomes negative in pressure in accordance with the up-and-down movements of the piston 24.

[0044] In Fig. 2, a breather pipe 80 is provided onto the top of the cylinder block 12. The breather pipe 80 has an end communicated with the inside of the valve gear room 34 via an opening 82, and the other end connected to the air cleaner 2.

[0045] The valve gear room 34 comprises oil returning channels 84 and 84'. Each of these has an end opened to the valve gear room 34 and the other end opened to the oil sump 18.

[0046] In such constitution, as shown in Fig. 1, being positioned with the valve gear room 34 up, in other words, in an upright state, the engine 1 holds proper amounts of lubricating oil in the crank room 16, oil sump 18, and valve gear room 34 in the case where the piston 24 is not in up-and-down motion.

[0047] When the engine 1 is started, the up-and-down movements of the piston 24 generate a change in pressure inside the crank room 16; that is, the ascending of the piston 24 depressurizes the crank room 16 into a negative pressure, and the descending of the same pressurizes the crank room 16 into a positive pressure.

[0048] The negative-pressurization of the crank room 16 produces a differential pressure between the crank room 16 and the oil sump 18. As a result, the oil held in the oil sump 18 is sent to the crank room 16 side through the inlet portion 40 and the paths T1, T2 of the intermittent il f eding secti n 46 (cf. Fig. 1) being provided in the rotating crankshaft 20 so as to be in communication with the oil sump 18 in the ascending of the piston 24.

[0049] The oil sent to the crank room 16 side is delivered to the crank webs 64, scattered from the end portions thereof about the inner walls of the crank room 16, and thereby partially formed into oil mist. Th thus produced oil mist lubricates the crankshaft 20, the piston 24, and other component parts in the crank room 16.

[0050] In the descending of the piston 24, the crank room 16 becomes positive in pressure, generating a differential pressure against the oil sump 18. In this case, the valve plate 74 in the unidirectional valve 70 (cf. Fig. 2) opens the valve hole 72, so that the oil mist held in the crank room 16 and the cylinder 12A is sent from the crank room 16 into the communicating channel 32 together with the pressurized air.

[0051] The oil mist sent into the communicating channel 32 is in turn sent toward the valve gear room 34 under the positive pressure, lubricating the component parts of the valve drive section 30 on the way.

[0052] The oil mist having lubricated the respective component parts of the valve drive section 30 is introduced to the valve gear room 34, in which the oil mist is separated into oil and air. The separated oil is let through the oil returning channels 84 and 84' to the oil sump 18 for recovery. Meanwhile, the separated air is let from the opening 82 through the breather pipe 80, and released into the air cleaner 2. Note that this air contains some amount of oil mist.

[0053] Next, in the cases where the engine 1 is used in an inverted state, the weight 43 arranged on the end of the inlet portion 40 changes its position along the direction of gravity inside the oil sump 18 to immerse the inlet portion 40 into the held oil, which carries out the supplying of oil to respective lubrication parts by utilizing the changes in pressure resulting from the up-and-down movements of the piston 24. The oil supply is also performed in the same way in the cases where the engine 1 in a slanted state.

[0054] Now, the constitution providing the features of the present embodiment will be explained below on the constitution of the lubricating apparatus described above.

[0055] With reference to Fig. 2, one of the two oil returning channels 84 and 84' of generally the same constitution having an end arranged inside the valve gear room 34 will now be described in constitutional detail. The other end of the oil returning channel 84 is opened to the top of the oil sump 18, and a bypass structure is arranged on the middle. Noted that, while description will be omitted thereon, the other oil returning channel 84' is of the same constitution as that of the oil returning channel 84.

[0056] The bypass structure is constituted by an oil inhaling channel 90 composed of: a branch channel 84A branching off of the oil returning channel 84; a path 84B

being capable of communication with an opening 24B positioned in an immediate lower portion of a skirt 24A of the piston 24 when the piston 24 is at the top dead center; and a path 84C for providing communication between the branch channel 84A and the path 84B. The opening 24B positioned in th immediate lower portion of the skirt 24A is pi rcing through th skirt 24A to provide communication to the inside of the cylinder 12A. Therefore, when communicated with the path 84B, the opening 24B allows the communication between the path 84B and the inside of the cylinder 12A.

[0057] Meanwhile, as shown in Fig. 2, the oil returning channel 84 is provided with a check valve 100 at its opening portion 84D positioned in an upper portion of the oil sump 18. The check valve 100 comprises a spherical body being prevented from dropping-out by a washer 96 which is supported between a bolt 95 and the lower surface of the crankcase 14. While in the present embodiment the spherical body constituting the check valve 100 is composed of a steel ball, it is obvious that the spherical body is not limited thereto, and may be of any other material as long as oilproof.

[0058] For example, the above-mentioned spherical body may be composed of a rubber ball of fluororubber, which is low in resilience and has oil- and heat-resistances.

[0059] Besides, in Fig. 1, in the vicinity of the communicating channel 32 for providing communication between the crank room 16 and the valve gear room 34, a pore 110 is formed in the partition wall 14A at the bottom of the crankcase 14 to provide communication with the oil sump 18.

[0060] As the present embodiment is of the above-described constitution, like the aforementioned case, a differential pressure is produced between the crank room 16 and the oil sump 18 in the ascending of the piston 24 with the engine 1 upright, causing a negative-pressurization tendency in the crank room 16. On this account, the oil held in the oil sump 18 is sent to the crank room 16 through the inlet portion 40 and the paths T1 and T2 of the intermittent oil feeding section 46 provided in the rotating crankshaft 20 so as to provide communication to the oil sump 18 in the ascending of the piston 24.

[0061] When the piston 24 reaches to the top dead center, the path 84B of the oil inhaling channel 90 formed in a part of the oil returning channel 84 from the valve gear room 34 is brought into communication with the opening 24B positioned in the immediate lower portion of the skirt 24A of the piston 24, thereby providing communication to the inside of the cylinder 12A. On this account, when the crank room 16 is negatively pressurized, the oil in the valve gear room 34 is taken into the oil inhaling channel 90 by the negative pressure which peaks at the top dead center of the piston 24, and inhaled through the opening 24B into the cylinder 12, as shown by arrows in Fig. 1. Therefore, most of the oil mist having fed to the valve gear room 34 is inhaled through the oil returning channel 84 into the cylinder 12A by the negative pressure in the crank room 16, and th remaining is sent through the opening portion 82 and the breather 80 to the air cleaner 2.

[0062] N w, the descending of the piston 24 turns the crank room 16 positive in pressure. The positive pressure opens the valve plate 74 of the unidirectional valve 70 constituting th second oil feeding means to send the oil misted by the crank webs 64 through the communicating channel 32 to the valve drive section 30 and the valve gear room 34.

[0063] The descending of the piston avoids excessive supply of oil to the valve drive section 30 and the valve gear room 34. That is, when the valve plate 74 in the unidirectional valve 70 is opened to let the oil misted inside the crank room 16 through the communicating channel 32, some of the oil let through the communicating channel 32 is released into the oil sump 18 through a pore 110, which is formed in the partition wall 14A of the crankcase 14 so as to be in communication between the communicating channel 32 and the oil sump 18. This accordingly adjusts the oil mist to be fed to the valve drive section 30 and the valve gear room 34 to its proper amount.

[0064] Now, in the cases where the engine 1 is in an inverted state, the oil sump 18 is positioned up. Therefore, the oil inside the oil sump 18 possibly flow backward through the oil returning channel 84 opening in the top of the oil sump 18. However, in the present embodiment, the spherical body in the check valve 100 is to close the opening portion 84D of the oil returning channel 84 to avoid the backflow of oil. Such condition is also obtained when the engine is in a slanted state.

[0065] According to the present embodiment, a bypass structure is provided on the oil returning channel 84 from the valve gear room 34, and via the oil inhaling channel 90 constituting the bypass structure the oil can be fed into the cylinder 12A through the opening 24B positioned in the immediate lower portion of the skirt 24A of the piston 24 being at the top dead center. Therefore, oil recovered from the valve gear room 34 can be fed substantially by force into the cylinder 12A which is one of the lubrication points.

[0066] Hereinafter, another embodiment of the present invention will be described.

[0067] Fig. 3 is a sectional view being equivalent to Fig. 2, illustrating the principal parts of a lubricating apparatus according to the another embodiment of the present invention. As shown in the figure, the present embodiment is characterized in that the oil contained in the blowby gas recovered from a valve gear room 34 is introduced into the cylinder 12A instead of being returned to the oil sump 18. Note that, in Fig. 3, the same component parts as those in Fig. 2 are designated by the same reference numerals and symbols.

[0068] In Fig. 3, at a position where a breather pipe 80 is communicated to an air cleaner 2 is arranged a breather room 2A, and from the breather room 2A is extended a pipe 120 for providing communication between

the breather room 2A and an il inhaling opening (for ease of description, designated by a referenc numeral 24B') formed in an immediate lower portion f a skirt 24A of a piston 24 being at the top dead center. The pipe 120 is connected t an oil inhaling channel 14B, which is formed in a cylinder 14 so as to be in communication with th aforesaid oil inhaling opening 24B', to provide communication between the aforesaid breather room 2A and the oil inhaling opening 24B'.

[0069] In this connection, the pipe 120 may be provided with a check valve (not shown) being capable of supplying oil into the cylinder 12A only when the cylinder 12A side is negative in pressure.

[0070] As the present embodiment is of the above-described constitution, in the descending of the piston 24, the blowby gas containing the oil mist is sent through a communicating channel 32 (cf. Fig. 2) to the valve gear room 34 to be separated into oil and air, which are in turn sent into oil returning channels 84, 84' and into an opening portion 82, respectively.

[0071] The oil-containing air sent into the opening portion 82 is let through the breather pipe 80 into the breather room 2A, in which the oil-containing air is yet separated into air and oil. By a negative pressure generated in the crank room 16 in the ascending of the piston 24, the oil separated in the breather room 2A is inhaled through the pipe 120 and the oil inhaling channel 14B into the oil inhaling opening 24B' positioned in the immediate lower portion of the skirt 24A of the piston 24, and fed into the cylinder 12A. By this means, after taken from the valve gear room 34 into the breather room 2A and separated, the oil is sent by force to a point inside the cylinder where the highest negative pressure is generated, and is newly supplied to the cylinder 12A for use in lubrication.

[0072] According to the present embodiment, the oil separated from air in the breather room 2A is inhaled into the cylinder 12A by the negative pressure created in the ascending of the piston 24. Therefore, the residual oil in the breather room 2A can be reduced in amount, thereby lowering the oil contamination of the air cleaner 2.

[0073] Moreover, as shown in Figs. 4 and 5, the oil returning channels 84 and 84' are provided with detachable oil suction means 130 onto their openings at the valve gear room 34 side.

[0074] In Fig. 4 and Fig. 6, each suction means 130 is composed of a flexible pipe formed in a curve so that the extremity thereof can be immersed into oil when the four-cycle engine 1 is put over sideways. In this connection, the oil level in the four-cycle engine 1 being put over sideways is shown by symbols L in Figs. 4 and 6, for ease of description, and the oil is to be held in the side shown by the arrows extending from the lines designated by the symbols L. Besides, in Figs. 4 and 6, the direction designated by a symbol U represents the upside, and the direction designated by a symbol D represents the downside of the engine being put over sideways.

[0075] As shown in Fig. 7, the il suction means 130 are to be inserted into the openings of the oil returning channels 84 and 84' or fitted to the outer peripheries of the openings for retention. Thus, the oil suction means 130 in the inserted or fitted state can be detached from th oil returning channels 84 and 84' by pulling off from the openings. Theref re, the oil suction means 130 can be mounted on and detached from the oil returning channels 84 and 84' depending on the use conditions of the four-cycle engine. Note that, in Fig. 7, the lines designated by the symbols L and the arrows extending from the lines represent the same meanings as those in the above-described case.

[0076] The oil suction means 130 have their extensions from the bents set in length so that the extremities thereof can get into the oil.

[0077] Next, the another embodiment will be described with reference to Fig. 8.

[0078] In Fig. 8, the oil suction means (for ease of description, designated by symbols 130A) in the another embodiment are fitted by insertion into the oil returning channels 84 and 84' so as to rotate freely about the longitudinal axes of the channels. On the outer peripheries of the extremities thereof, as shown in Fig. 8, are mounted weight members 131 so as to direct the oil suction means 130A in the direction of gravity. Accordingly, when the engine 1 is set over sideways, the extremities can be directed toward the deepest position of the oil held inside the valve gear room 34 by means of the weights of the weight members 131.

[0079] As for yet another embodiment, the aforesaid oil suction means may be modified in their material properties.

[0080] In Fig. 9, oil suction means (for ease of description, designated by symbols 130B) are composed of flexible pipes having weight members 131 mounted on the outer peripheries of their extremities. In this case, it is obvious that the oil suction means 130B have oil-resistance as well as flexibility.

[0081] In such constitution, even when the oil suction means 130B are set in length so that the extremities thereof are contacted with the internal walls of the valve gear room 34, their flexibility allows the extremities to be immersed into the oil, and permits the communication between the oil returning channels 84, 84' and the oil inside the valve gear room 34 in any position of the engine 1 including a sideways position. This accordingly allows the returning of oil from the inside of the valve gear room 34 to be securely carried out via the oil returning channels 84 and 84'.

[0082] In constitutions as described above, the extremities of the oil suction means 130, 130A, or 130B are kept immersed into the oil even in the cases where the engine 1 is put over sideways in use while the oil inside the valve gear room 34 moves to lower portions depending on the direction of the engine 1. Therefore, the communication can always be maintained between

the oil in the valve g ar room 34 and the oil returning channels 84 and 84', so that the returning of oil component from the valve gear room 34 to the oil sump 18 can be carried out securely.

[0083] While the presently preferred embodiments of this invention have been shown and described above, it is to be understood that disclosures are for the purpose of illustration and that various changes and modifications may be made without departing from the scope of the invention as set forth in the appended claims.

## Claims

1. A lubricating apparatus in a four-stroke engine, for feeding oil from an oil sump (18) provided in the vicinity of a crank chamber (16) to said crank chamber (16) and to a valve gear chamber (34) containing an intake and exhaust valve mechanism to carry out lubrication of parts and circulate the oil, characterised in that:

   said oil sump (18) is partitioned from said crank room (16) to avoid oil leakage in any slanted state;
   a first oil feed means (46) has an inlet portion (40) configured so that the end thereof always remains under the oil surface in said oil sump (18) regardless of the slanted state of said oil sump (18), said first oil feed means (46) capable of feeding the oil in said oil sump (18) through said inlet portion (40) to said crank chamber (16) by means of a vacuum pressure generated in said crank chamber (16),
   an agitating section provided in said crank chamber (16) for agitating the oil fed by said first oil feed means (46) into an oil mist,
   a communicating channel (32) providing communication between said crank chamber (16) and said valve gear chamber (34),
   a second oil feed means (70) for feeding the oil mist in said crank chamber (16) through said communicating channel (32) to said valve gear chamber (34) by means of a high pressure generated in said crank chamber (16), and an oil induction channel (90) is branched from the middle of an oil return channel (84, 84') providing communication with an opening (24B) positioned in a lower portion of a skirt (24A) of a piston (24) at top dead center, said oil return channel (84, 84') communicating between said valve gear chamber (34) and said oil sump (18); and
   an opening portion (84D) of said oil return channel (84, 84') to said oil sump (18) is provided with a check valve (100) which opens when the engine is upright and closes when the engine is inverted or slanted.

2. A lubricating apparatus according to claim 1, wherein said check valve (100) is composed of a spherical body for opening and closing said opening portion (84D) by means of its own weight.

3. A lubricating apparatus according to claim 1 or claim 2, wherein a pore (110) provides communication between said oil sump (18) and said communicating channel (32).

4. A lubricating apparatus according to any one of claims 1 to 3, wherein a breather pipe (80) communicates between said valve gear chamber and a breather chamber (2A) of an air cleaner (2), and a pipe (120) is arranged to communicate between said breather chamber (2A) and an oil induction opening (24B') formed in a lower portion of the skirt (24A) of said piston (24) at top dead center to feed the oil held in a lower part of said breather chamber (2A) into a cylinder (12A) through the oil induction opening (24B') when said piston (24) is at top dead center.

5. A lubricating apparatus in a four-stroke engine, for feeding oil from an oil sump (18) provided in the vicinity of a crank chamber (16) to said crank chamber (16) and to a valve gear chamber (34) containing an intake and exhaust valve mechanism to carry out lubrication of parts and circulate the oil, characterised in that:

   said oil sump (18) is partitioned from said crank chamber (16) so as to avoid oil leakage in any slanted state;
   a first oil feed means (46) has an inlet portion (40) configured so that the end thereof always remains under the oil surface in said oil sump (18) regardless of the slanted state of said oil sump (18), said first oil feed means (46) is provided to feed the oil in said oil sump (18) through said inlet portion (40) to said crank chamber (16) by means of a vacuum pressure generated in said crank chamber (16),
   an agitating section provided in said crank chamber (16) for agitating the oil fed by said first oil feed means (46) into an oil mist,
   a communicating channel (32) communicating between said crank chamber (16) and said valve gear chamber (34).
   a second oil feed means (70) for feeding the oil mist in said crank chamber (16) through said communicating channel (32) to said valve gear chamber (34) by means of a high pressure generated in said crank chamber (16), and
   an oil induction channel (90) branched from the middle of an oil return channel (84, 84') to provide communication with an opening (24B) positioned in a lower portion of a skirt (24A) of a

piston (24) at top dead center, said il return channel (84, 84') communicating between said valv gear chamber (34) and said oil sump (18); and

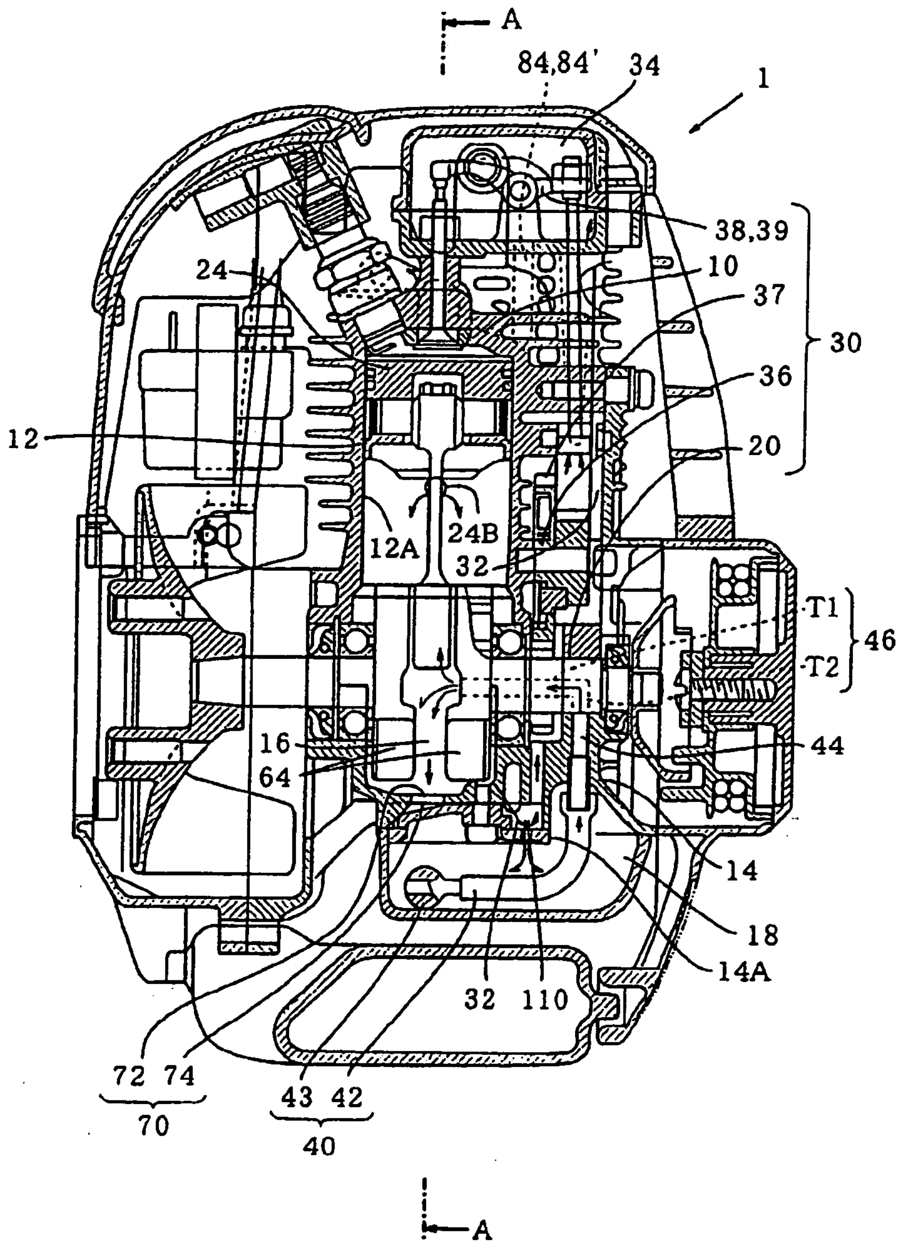
said oil return channel (84, 84') has an oil suction means (130) detachably attached at its opening in said valve gear chamber (34), said oil suction means (130) having an extremity arranged for immersion into oil collected in the valve gear chamber (34) when the engine is put on its side.

6. A lubricating apparatus in a four-stroke engine according to claim 5, wherein said oil suction means (130) is composed of a pipe (130A) formed from said oil return channel (84, 84') which is bent, rotates freely about the longitudinal axial center of said oil return channel (84, 84'), and has a weight member (131) mounted on said extremity to be immersed into the oil.

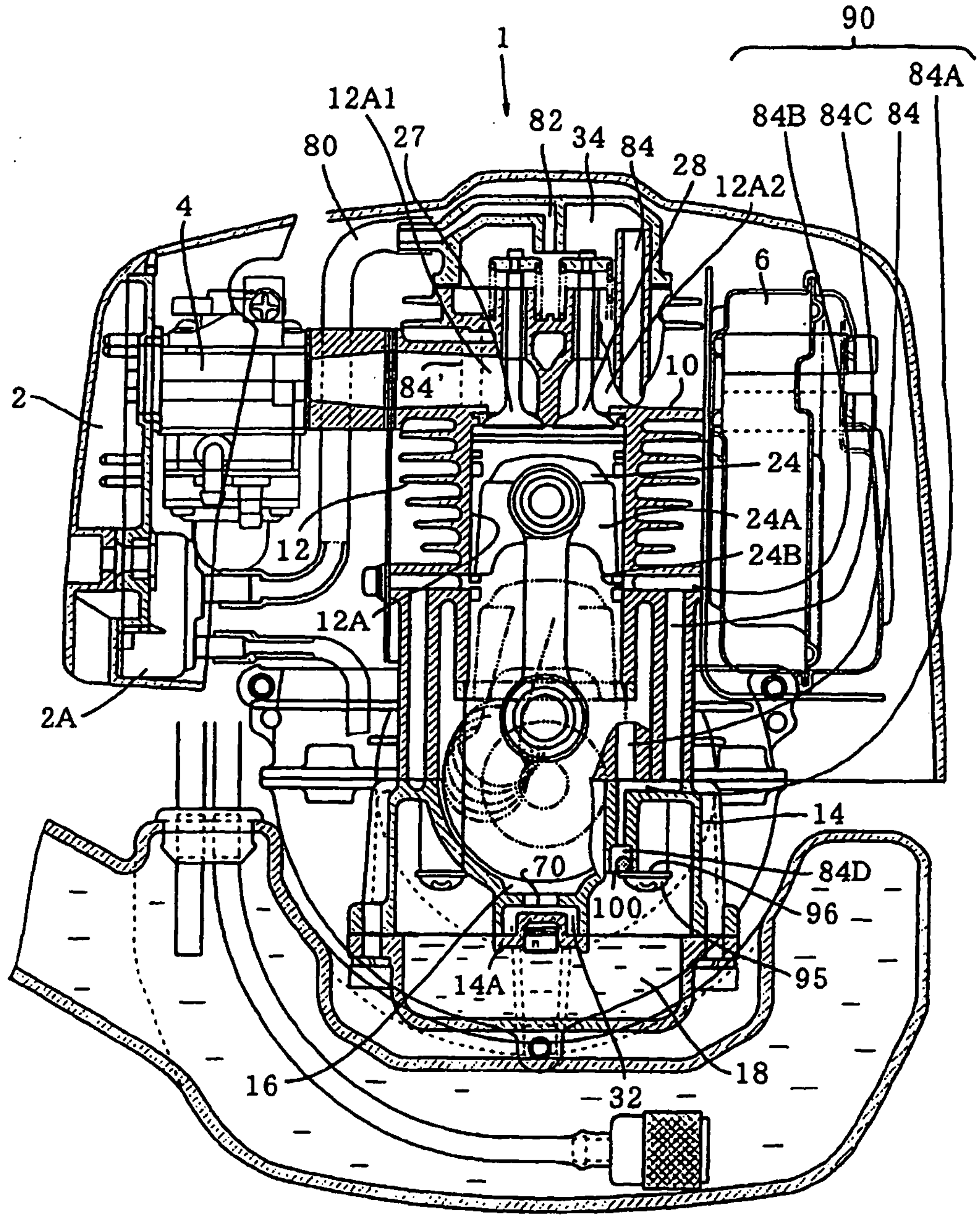
7. A lubricating apparatus according to claim 6, wherein said oil suction means (130) is a rigid bent pipe (130A).

8. A lubricating apparatus in a four-stroke engine according to claim 5, wherein: said oil suction means (130) is formed of a flexible pipe (130B), and has a weight member (121) mounted on said extremity to be immersed into the oil.

FIG.1


A
84,84'
34
1
38,39
24
10
37
30
36
12
20
12A
24B
32
T1
46
T2
16
44
64
14
18
14A
32
110
72
74
70
43
42
40
A

# FIG.2



90
1
84A
12A1
82
84B
84C
84
80
27
34
84
28
12A2
4
6
84'
10
2
24
12
24A
24B
12A
2A
14
70
84D
100
96
95
14A
16
18
32

FIG.3

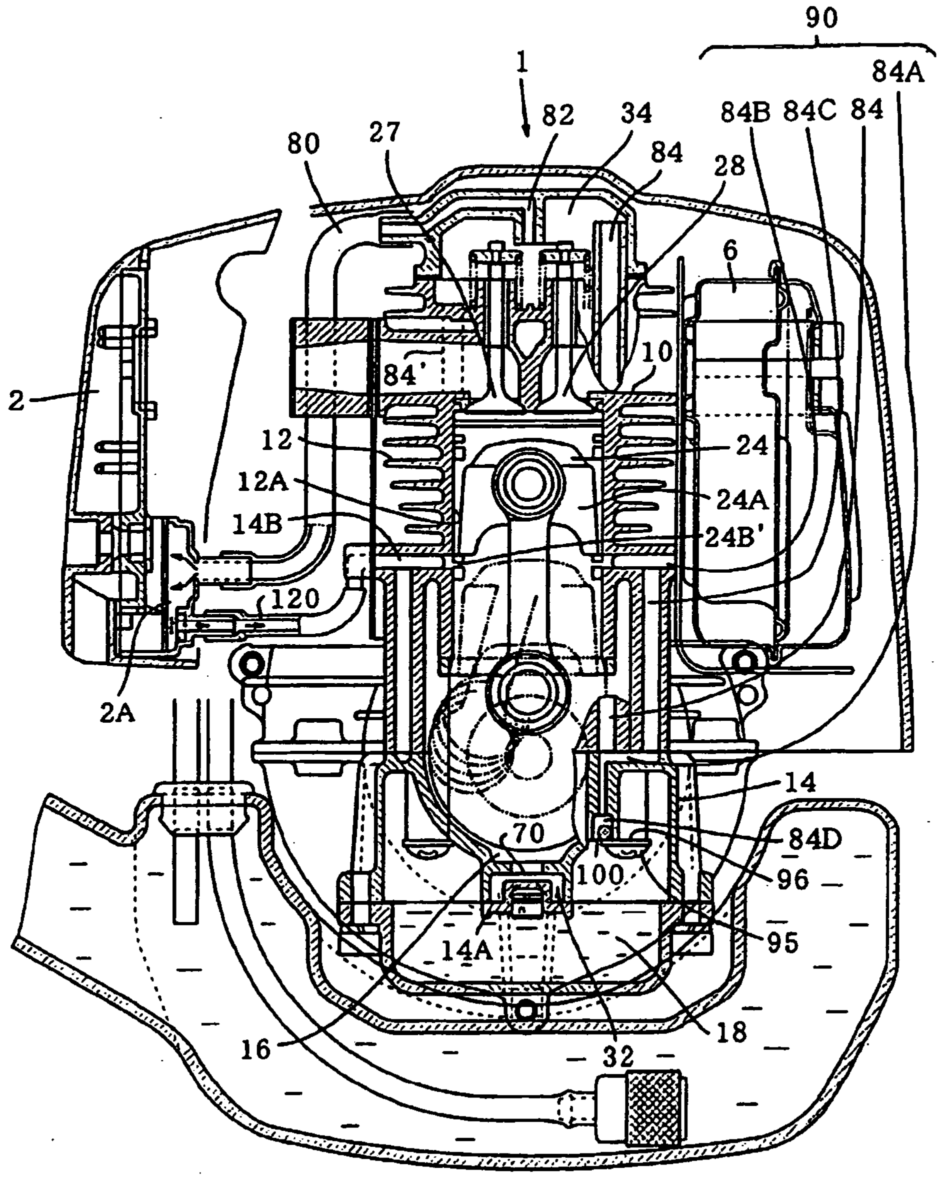

90
1
84A
82
34
84B
84C
84
80
27
84
28
6
2
84'
10
12
24
12A
24A
14B
24B'
120
2A
14
70
84D
100
96
14A
95
16
32
18

FIG.4

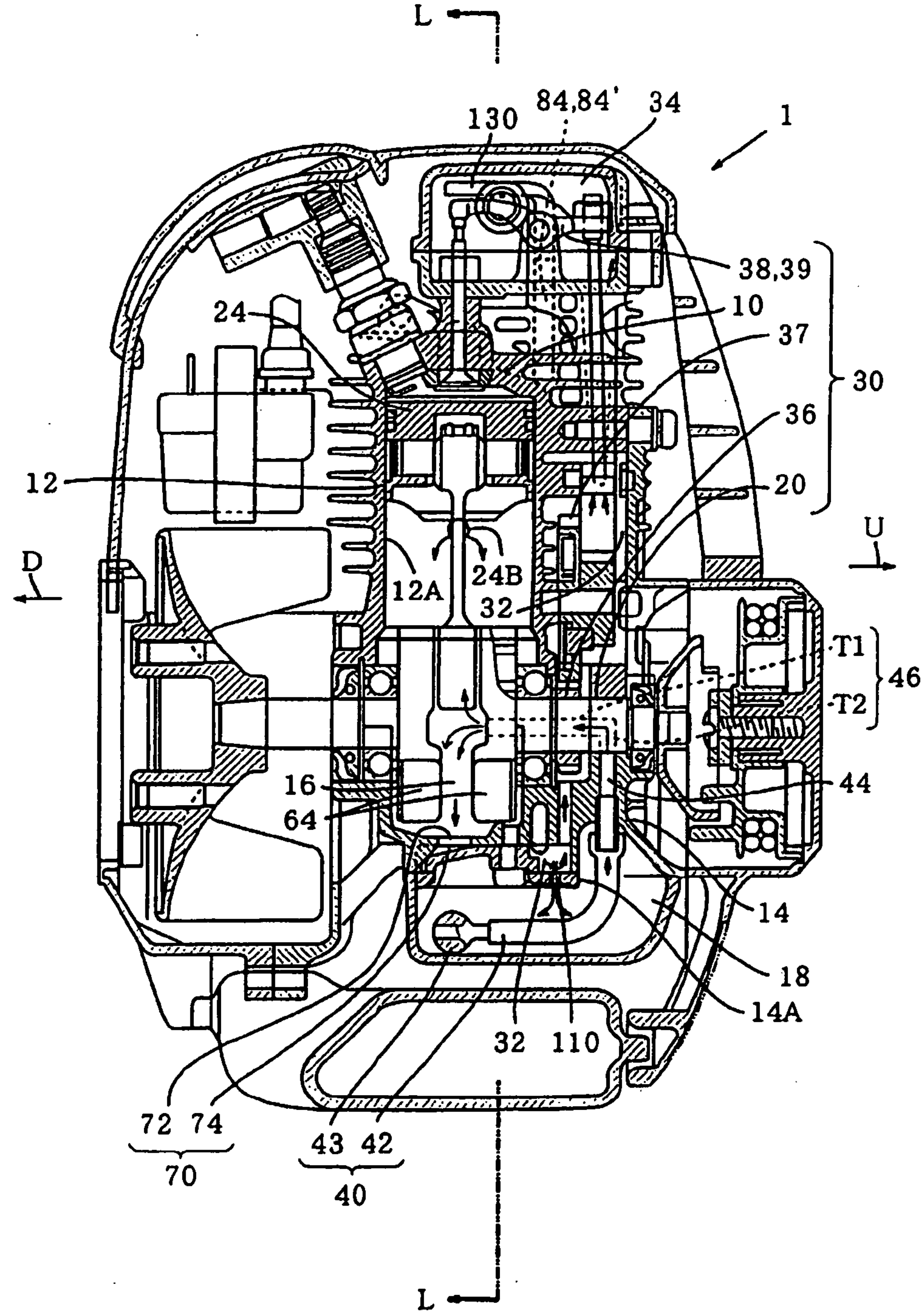

L
130
84,84'
34
1
38,39
24
10
37
30
36
12
20
U
D
12A
24B
32
T1
46
T2
16
44
64
14
18
14A
32
110
72
74
70
43
42
40
L

FIG.5

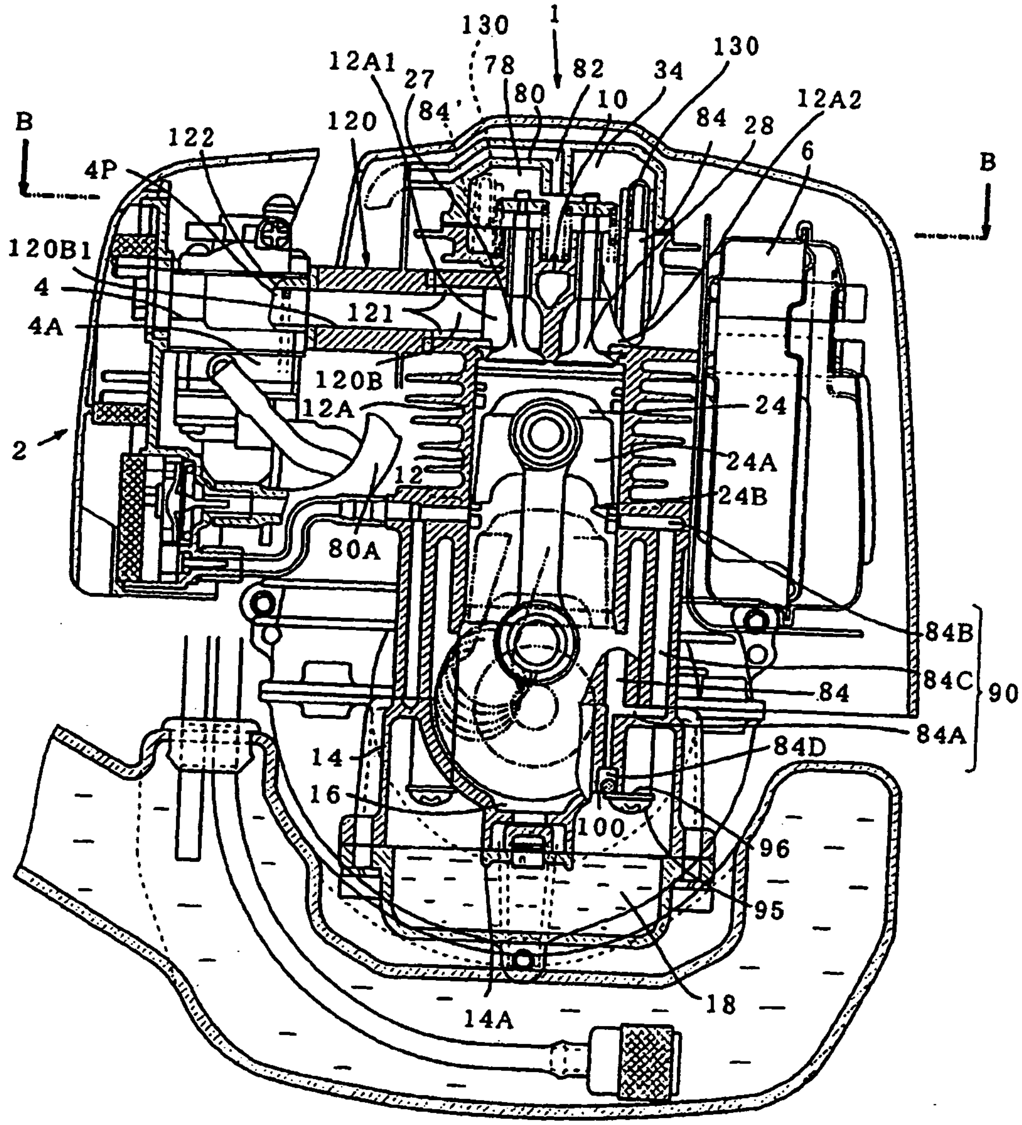

1
130
130
12A1
27
78
82
34
80
10
84'
84
28
12A2
6
B
B
122
120
4P
120B1
4
121
4A
120B
12A
24
2
24A
12
24B
80A
84B
84C
90
84
84A
84D
14
16
100
96
95
18
14A

FIG.6

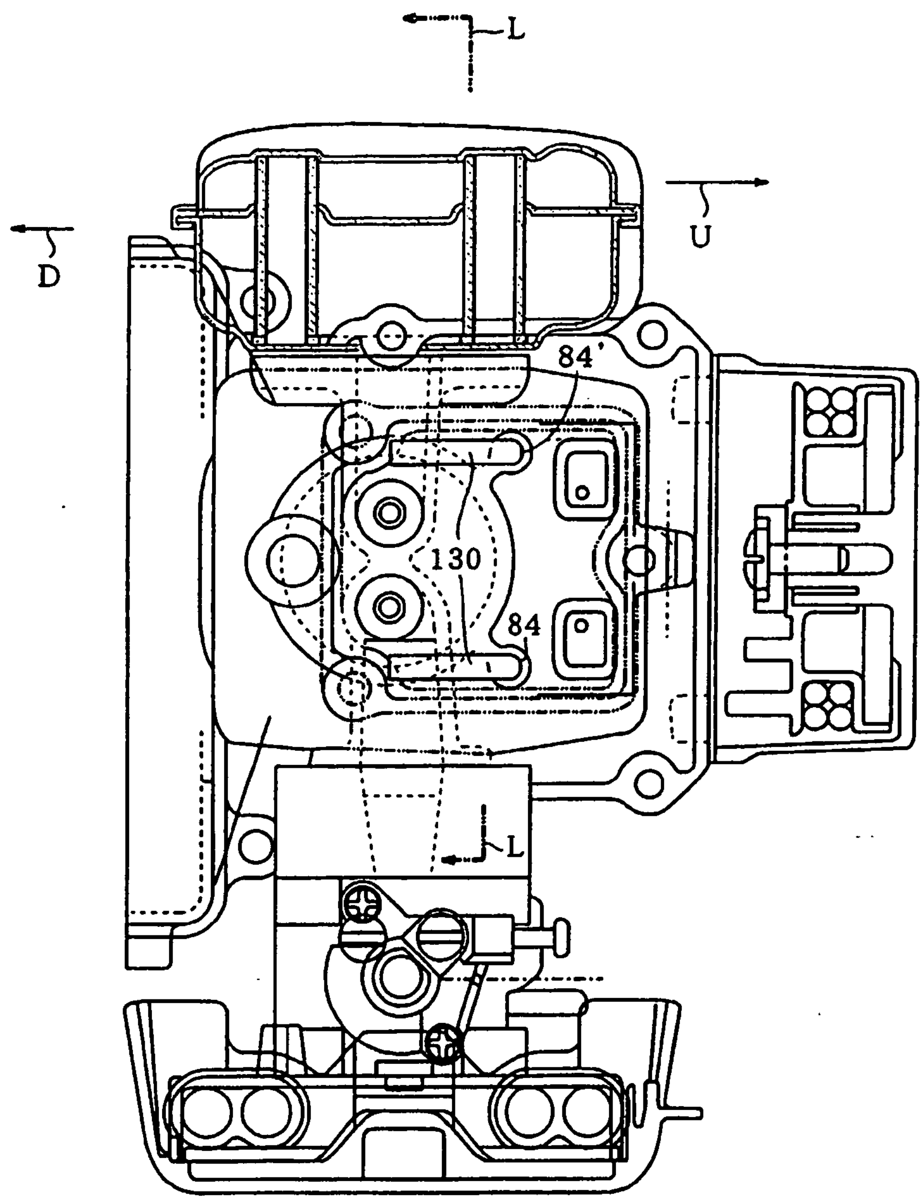


FIG.7

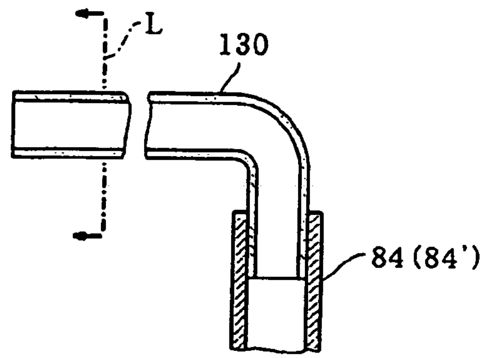



FIG.8

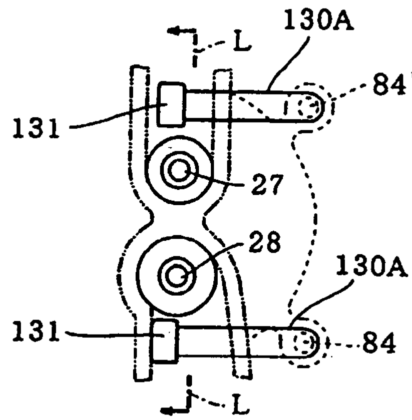
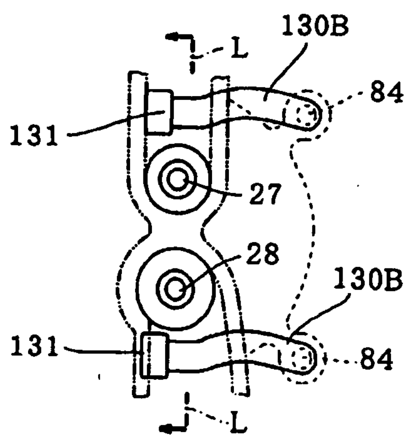



FIG.9



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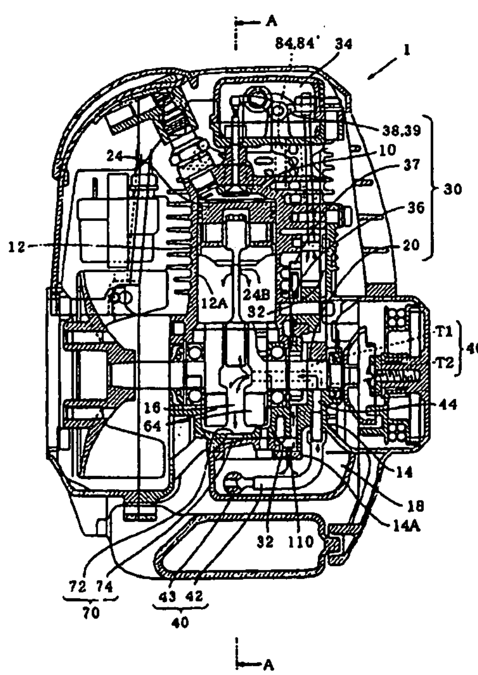
# (54) Lubricating apparatus in a four-stroke engines

(57) A lubricating apparatus for small-sized four-cycle engines to be used in portable type bush cutters, knapsack type powered sprayers, etc. In the lubricating apparatus, an oil returning channel (84, 84') is arranged to provide communication between a valve gear room (34) and an oil sump (18), and an oil inhaling channel (90) is branched from the middle of the oil returning channel so as to provide communication to an opening (24B) in an immediate lower portion of a skirt (24A) of a piston (24) being at the top dead center. By this means, when a crank room (16) is negatively pressurized, the oil sucked from the valve gear room is taken through the oil inhaling channel being in communication to a point inside a cylinder (12A) where the highest negative pressure is generated, and fed into the cylinder. An opening portion (84D) of the oil returning channel is provided with a check valve (100) for opening when the engine is upright and closing when the engine inverted or slanted to prevent the backflow of oil from the oil sump to the oil returning channel. In order to carry out the returning of oil to the oil sump securely, the valve gear room further comprises an oil inhaling means (130) being capable of immersing its extremity into the oil collected inside the valve gear room when the engine is put over sideways.

FIG.1

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Application Number
EP 99 30 4175

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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| THE HAGUE | 3 December 1999 | Mouton, J |

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